# Space Weather Technical Forecast

Issued on Tuesday, 14 May 2024 at 01:17 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

*Please note: On the 14 May between 1500 UTC and 2100 UTC, a significant data outage at NOAA SWPC is expected which will impact most of our observational data feeds and some models. We may receive data intermittently through that period. MOSWOC service will continue on contingency. Alerts and warnings will be sent using alternative data, if available. The planned data outage may be postponed in the event of significant space weather.*

**Space Weather Forecast Headline: A reducing risk of G1-G2 (Minor-Moderate) Geomagnetic storms days 1-2 (14-15 May). Chance of X-class flares from AR3664 mainly day 1 (14 May) before easing.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Moderate with a long period M6.6 flare observed at 13/0944 UTC from AR3664, which is now close to the southwest limb. There are fourteen sunspot regions on the disc, with AR3664 remaining the most notable. This has continued to show development within its magnetic looping on SDO imagery, but is now approaching on the southwest limb and is subsequently becoming more difficult to analyse. Given the history, size and complexity of the spot, this is expected to dominate the solar activity on the disc even as it rotates over the limb, with all other regions smaller and generally simpler. AR3676 near south-centre did contain a very small delta spot, which has since faded.

Further faint CMEs have been produced by AR3664, along with a much more notable CME from the long period M6.6-flare, which has been analysed and is considered to missing ahead of Earth, although the shock associated with this feature may glance us on day 2 (15 May), although this is low confidence. No other Earth-directed CMEs have been observed in the past 24 hours.

**Solar Wind / Geomagnetic Activity:** Solar winds observed at L1/ACE started the period at very strong levels, above 800km/s, with a steady decline to the current Elevated levels, near 550km/s. Density has varied average to below average throughout the period. Total Interplanetary Magnetic Field (IMF), Bt, persisted at Weak to Moderate levels, varying between 4-10nT, with the north-south component, Bz, starting the period negative (southward), with a minimum values of -6 nT, but became mostly positive (northward) from 13/1200 UTC. Geomagnetic activity was at G1-G2/Minor-Moderate storm level to begin with, between 13/0000-0600 UTC, declining to mostly Quiet to Unsettled (Kp2-3) conditions.

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10MeV) observed at GOES18 is currently above the S1 threshold, following the long period M6.6 flare at 13/0944 UTC. High energy electron flux (greater than 2MeV) observed at GOES16 was Background to Moderate, reaching 754 pfu at 13/1515 UTC. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 14/0000 UTC was 4.52e6 integrated pfu.

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# Met Office Space Weather Technical Forecast

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Further isolated X-class flares are likely day 1 (14 May) from AR3664 on the southwest limb, along with occasional M-class flares being expected.

**Solar Wind / Geomagnetic Activity:** The M6.6 flare from AR3664 on the southwest limb produced a CME, which has been analysed and is considered to be mostly missing ahead of Earth, although its associated shock may glance the Earth late on day 2 (15 May), although this is low confidence. No other Earth-directed CMEs currently feature in the forecast. Otherwise, ongoing CME enhanced solar winds, along with any slight influence from CH36/+ is expected to gradually ease. Activity is expected to be Unsettled to Active at first with an ongoing potential for further G1-G2 Minor-Moderate storms. However, this risk declines through days 1-2 (14-15 May) with mainly Quiet to Unsettled conditions expected by days 3-4 (16-17 May) along with a slight chance of Active intervals.

**Energetic Particles / Solar Radiation:** GOES-18 proton flux has recently shown an uptick in response to the M6.6 flare at 13/0944 UTC and is currently above the S1 threshold. Proton flux should gradually decline over the coming days as AR3664 rotates off the disc by the end of day 1 (14 May). High energy electron flux is also forecast to rise as solar winds ease, with any charging that has occurred at lower orbits expanding out to GEO. This brings a likelihood of High electron flux during the forecast period, along with a chance of Active electron fluence.

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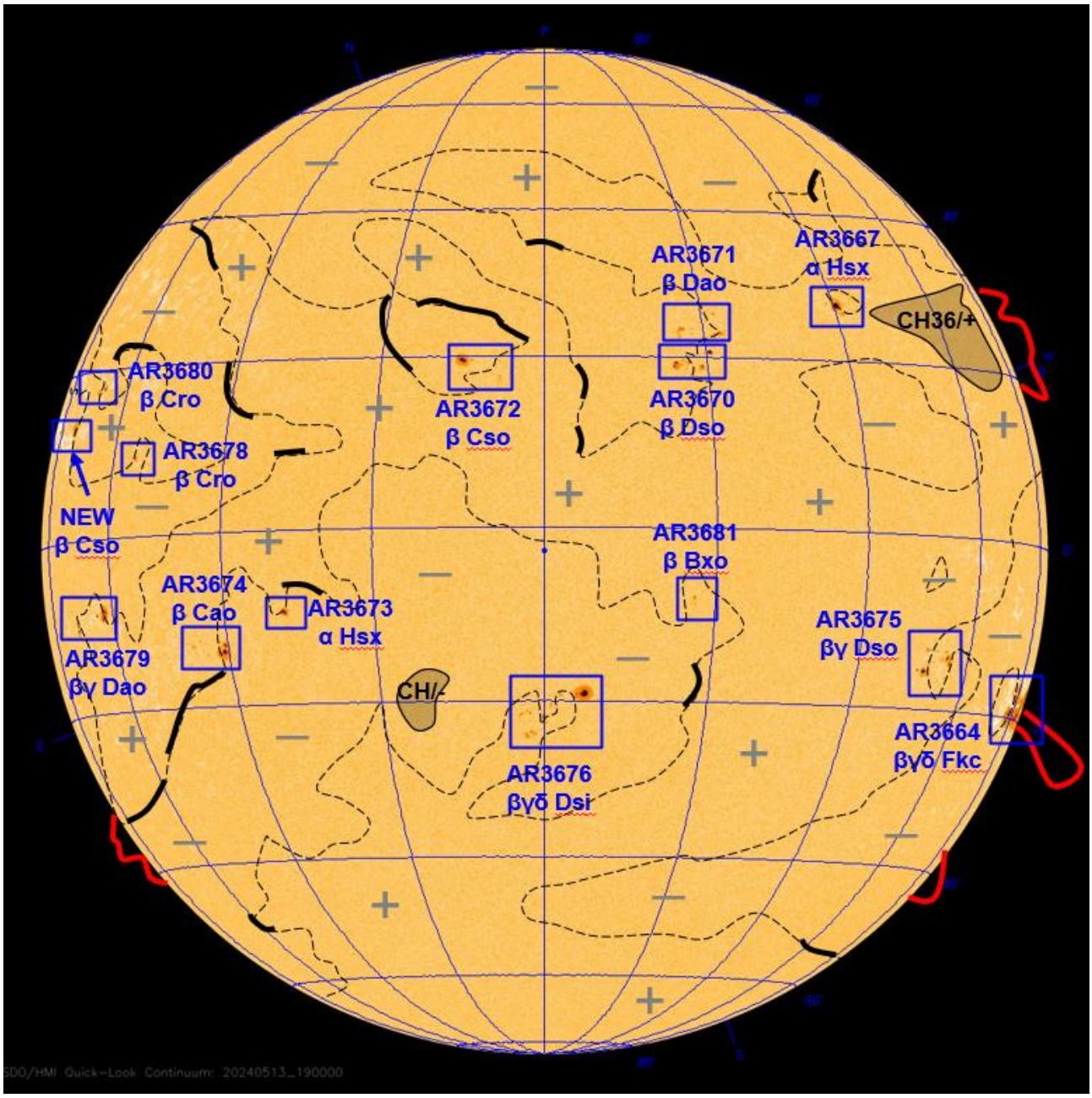
**Figure 1. Solar Analysis Valid 13/1900 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There are no further CME's currently expected to arrive at Earth during the period, however due to the number of CMEs that have been released from AR3664, ongoing glancing influences from those passing ahead of Earth cannot be ruled out on days 1 and 2 (14-15 May), including the CME from the M8.8 flare on 11 May, and possibly from M6.6 flare and its associated CME, which occurred early on May 13.

Otherwise the recently enhanced geo-space environment is expected to ease towards background conditions, although perhaps initially seeing the decline of wind speeds delayed due to any influence from the HSS of CH36/+, although this is likely to have a negligible effect on the geomagnetic activity.

Overall activity is expected to be Unsettled to Active at first, but due to the strength of the solar wind, coupled with any passing CME influence, there is an ongoing likelihood of further G1-G2 Minor-Moderate storms. However, this risk declines through days 1-2 (14-15 May) with mainly Quiet to Unsettled conditions expected by days 3 and 4 (16-17 May) with a slight chance of Active intervals.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | Yes | 25 | 10 | 5 | 5 |
| Strong | G3 | No | 10 | 5 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

No further Earth-directed CMEs currently expected – although the shock associated with the long-period M6.6 flare CME (13 May) could possibly glance Earth on day 2 (May 15) – low confidence.

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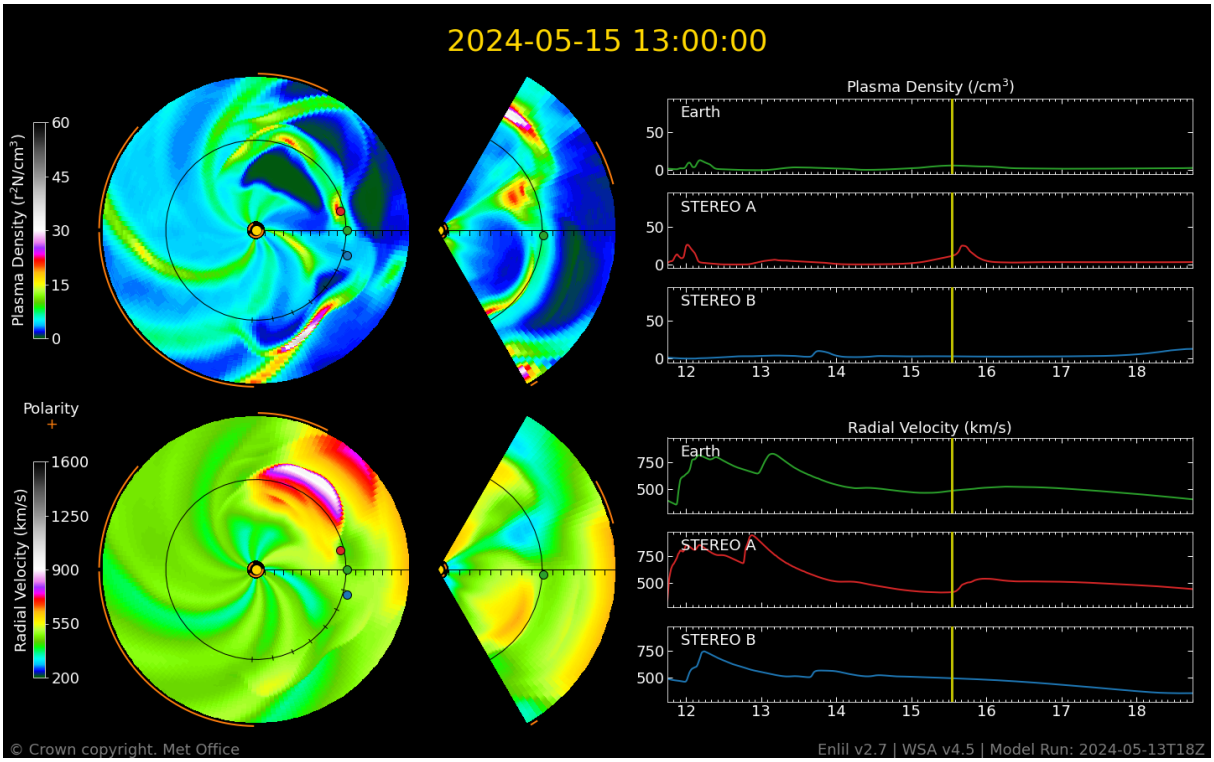
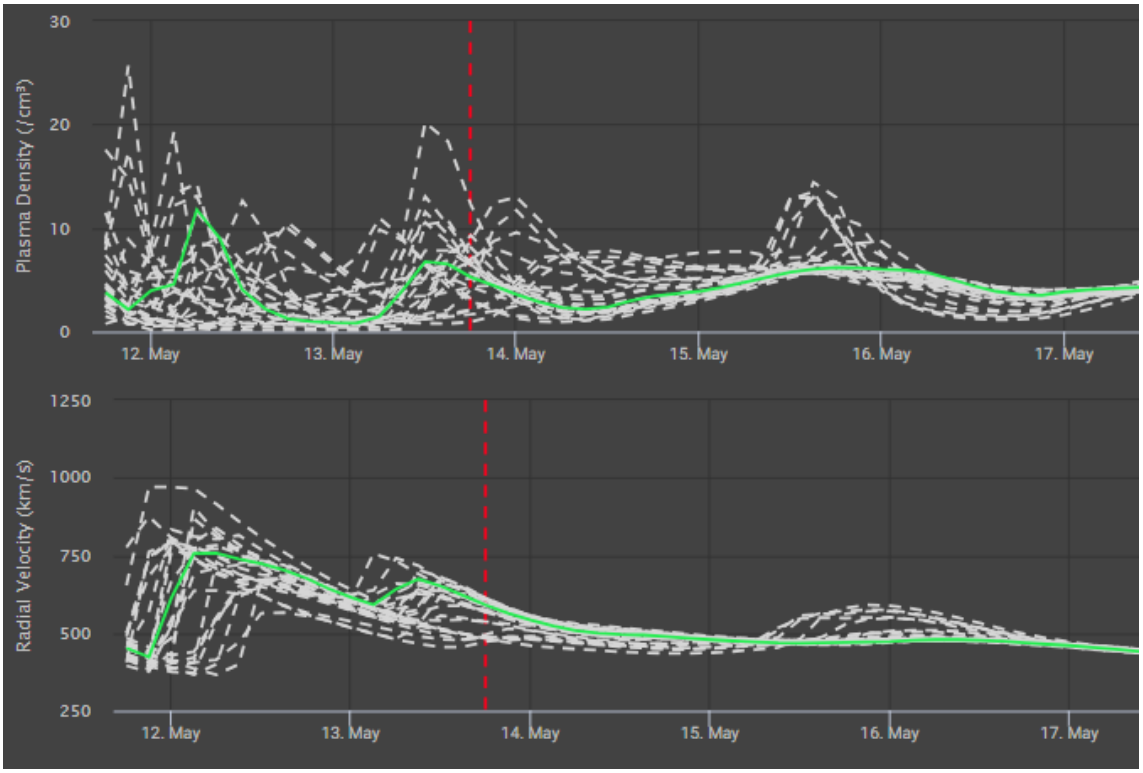
**Figure 2: MOSWOC Enlil and Ensemble – note the possible glance (in ensemble) on 15 May – low confidence.**

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**Radio Blackouts - X-Ray Flares:**
Activity is expected to remain High to Moderate day 1(14 May), with further M-flares expected, and a likelihood of isolated X-flares.

This risk is predominately from AR3664, now on the southwest limb. This has remained a very large and very active sunspot, with seven X-class flares and numerous M-flares observed between the 08 and 12 May. While analysis of the region is now difficult due to the regions location, similar flares remain likely, even as this moves onto the far-side during day 1 (14 May). This is supported by the significant looping visible in SDO imagery above the spot which is showing sign of development and instability. An R4-R5 blackout (X10+ flare) cannot be completely ruled out, before the sunspot and its looping disappears completely over the limb.

There are a total of fourteen sunspot regions on the disc, however aside from AR3664, they are much smaller and simpler providing only a chance of isolated M-flares. There is also a general slow growth trend on a number of the spots.

| X Ray Flares<br>Probability | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **R1-R2 M Class** | Yes | 90 | 60 | 40 | 20 |
| **Very Active** | **R3 to R5 X Class** | No | 70 | 25 | 5 | 5 |

**Figure 3: SDO imagery shows AR3664 on the SW limb, following the M6.6 – note the magnetic looping and flux.**

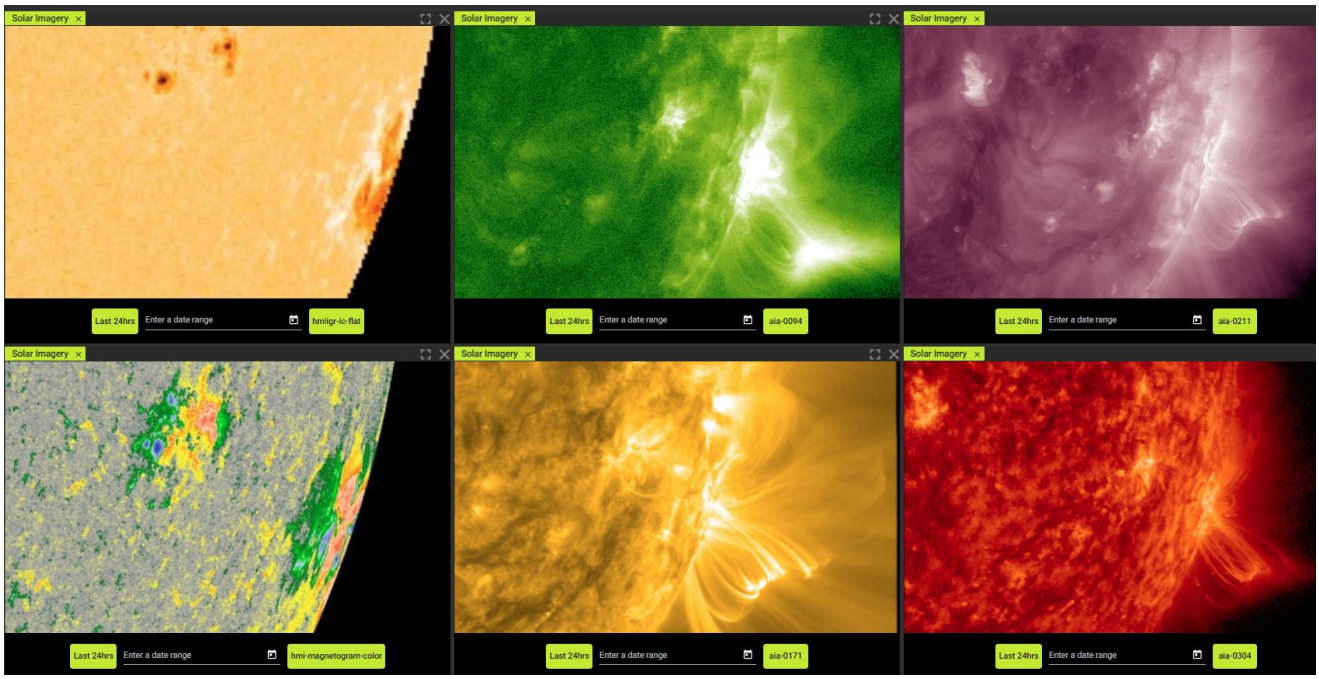


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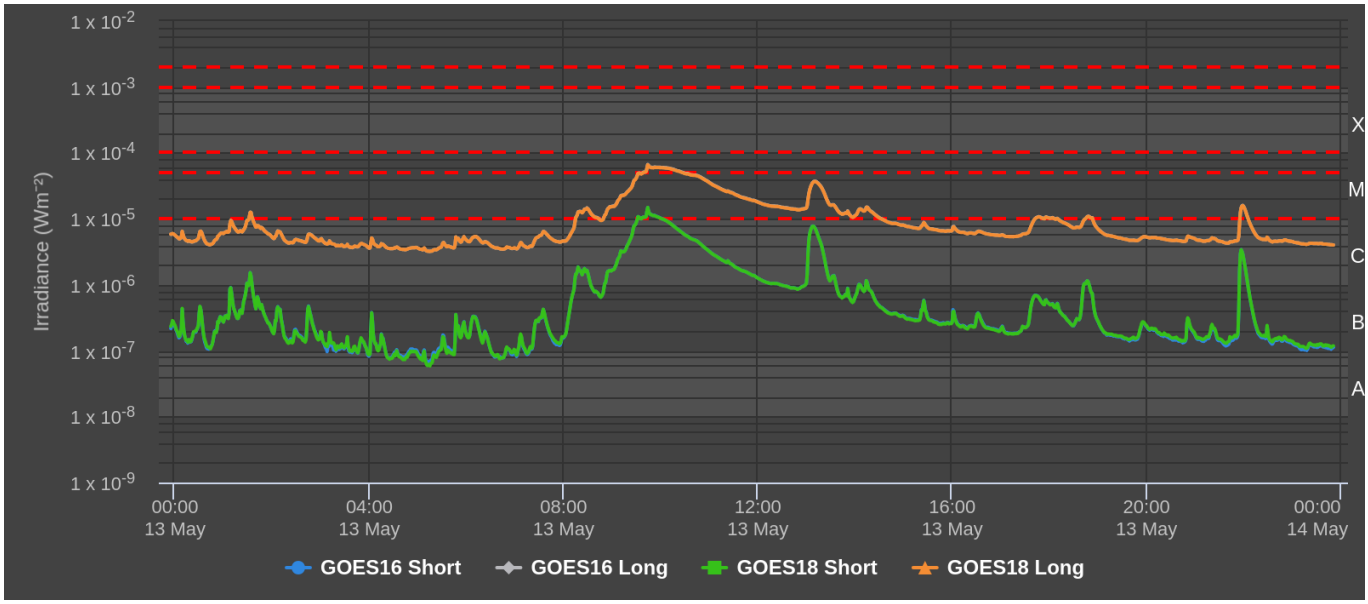
**Figure 4: GOES18 X-Ray flux trace.**




## Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES-18 is currently above the S1 threshold (10 MeV), following the long-period M6.6 flare at 13/0944 UTC from AR3664 on the southwest limb. A Type IV radio burst was also associated with the aforementioned flare.

AR3664 continues to be a large and potent spot, now on the southwest limb, with any subsequent flare activity having the potential to release further high energy protons that follow the Parker Spiral back to Earth. This will continue to bring a chance of further S1-S2 Radiation Storms, with a slight chance of reaching greater than S3 should any further X-flares occur.

| Radiation Storms | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ S1 | Yes | 80 | 50 | 10 | 10 |
| Very Active | ≥ S3 * | No | 15 | 10 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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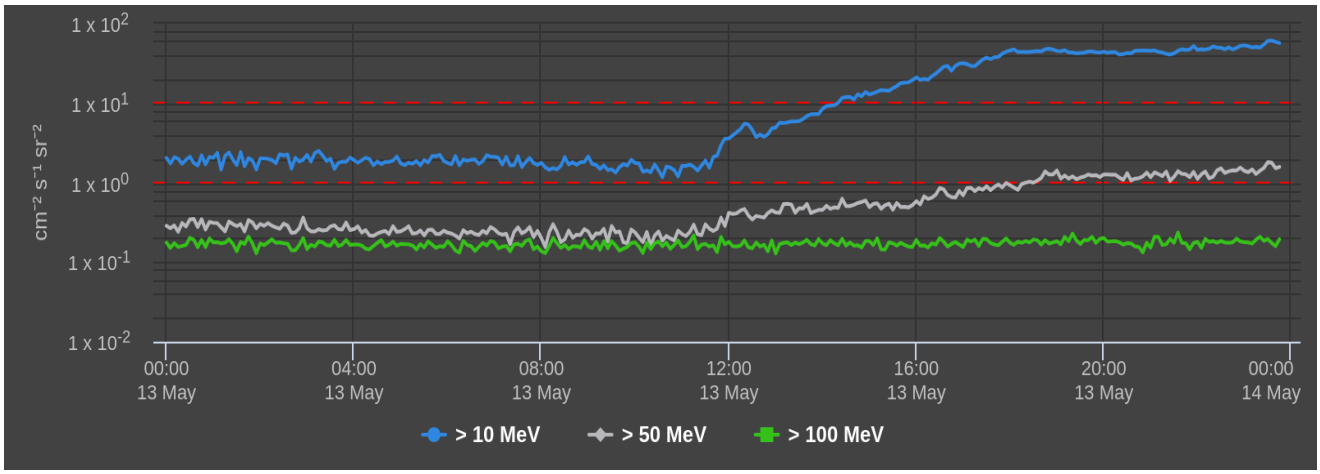
**Figure 5: GOES16 Proton Flux – currently above the S1 threshold following the recent long-period M6.6 flare from AR3664.**




## High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16 is currently Background to briefly Moderate, but is likely to see a significant increase during the period, as solar winds ease. The CME arrivals have likely resulted in a charging at lower orbits, and as the Van Allen belts ease back towards GEO, this charging is expected to bring initially more persistent Moderate flux, but likely persistently High electron flux by day 2 (15 May).

The associated 24 fluence will subsequently respond with a gradual rising trend, with a likelihood of reaching Active by the end of day 2 (15 May). This rising trend is supported by MOSWOC REFM, although the model is currently overestimating forecast values.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 30 | 60 | 60 | 60 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 5 | 5 | 5 |

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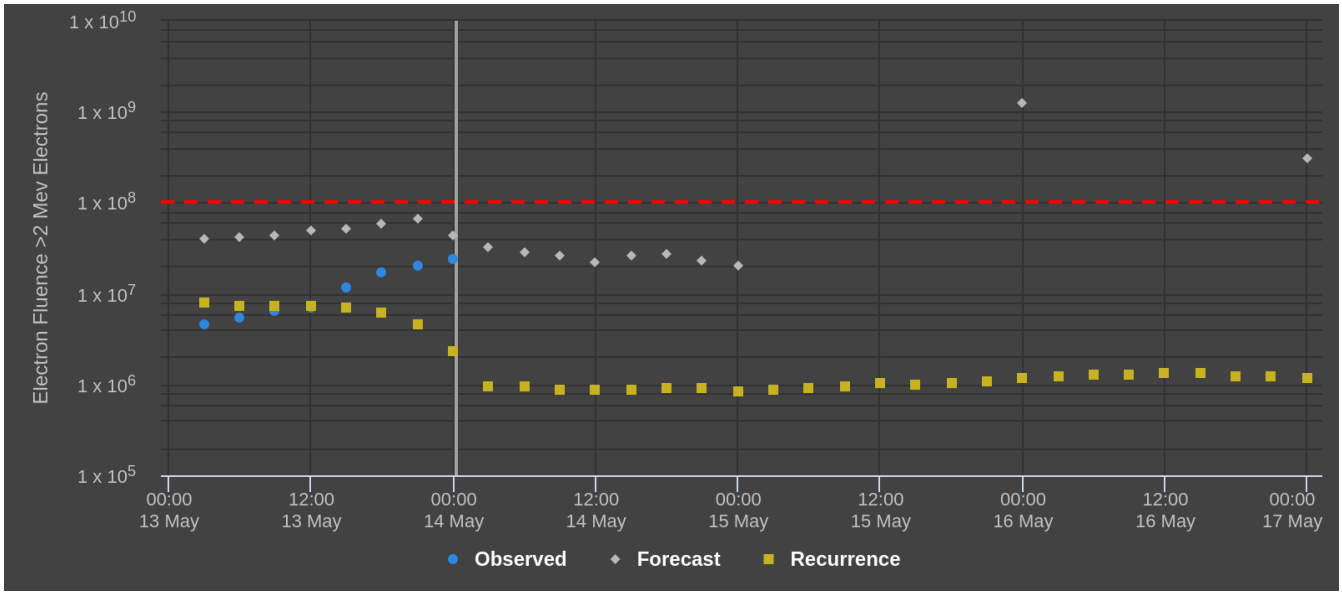
**Figure 5: MOSWOC REFM electron fluence.**

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